

Supplementary Data on the Androconial Scales of some Holarctic species of *Pieris* (Lepidoptera)

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My short note on the Nearctic *Pieris* of the *napi* group (Warren 1963), was an effort to establish the features of the androconial scales appertaining to each species or race. The scale characterisation was of a very complex nature, variation very marked but abrupt and discontinuous. Four trends of scale development can be noted: (a) the obvious affinity between most Nearctic insects and the Asiatic species *P. narina*, both in type and range of variation; (b) the occurrence of well-developed *bryoniae*-like scales in the same races as the "a" types; (c) the presence, occasionally in number, of asymmetrical forms and malformation, and (d) a pure *bryoniae* line. The significance of this mixture of characters was not realised at that time. It was two years later before the existence of the Palaearctic hybrid species was recognized. Study of more adequate material and a better understanding of the facts, now shows that most Nearctic forms have originated not from a number of pure, independent lines, but from an amalgamation of two, which, as will be shown later, were in all probability aboriginal forms of the Asiatic species *P. narina* and *P. dulcinea*.

The scale development indicates two groups of Nearctic species, which may be called the *oleracea*-group and the *bryoniae*-group. All the *oleracea* forms display the mixture of characteristics described under "a", "b" and "c", which naturally obscures such individual trends as exist. The *bryoniae*-group "d", includes two races displaying pure *bryoniae* characters; the large, pear-shaped, primitive scale, being conspicuous; this scale is more or less rectangular in the *oleracea*-group.

The scale type of the 1st generations of most *oleracea* species is a very primitive one; i.e., there is little neck development. This type is close, often identical to, that of *P. narina*. A glance at the plates will show this. Fig. 1 is a normal *narina* form, which varies towards fig. 8; fig. 2, *virginiensis*; fig. 3, *oleracea* 1st generation southern race; fig. 4, *oleracea* single generation northern race; fig. 13, *macdunnoughii* 1st generation; fig. 14, *venosa* 1st generation. In the last two and *virginiensis* this type predominates, in other species it is frequent. It is impossible to look at these figures without realizing that all are deviations of the same type. Such variation as occurs constitutes an advance in neck development or a rounding off of the general contours, as in figs. 15, 16 and 19. These illustrate what I called the "bryoniae" formation; in it one sees the effect of the *dulcinea* element, but of course it is not typical of either *bryoniae* or *dulcinea*. It is noteworthy that the two specimens from which figs. 19 and 4 came, were taken on the same ground, together with others giving more variable forms.

Malformation seems to occur with greatest frequency in the 2nd and single generation. It appears in countless forms. Scales vary in length, width and shape, the contours of the two sides differ, concavities or excrescences occur on any area of the perimeter; the basal prongs differ endlessly being short or long or unequal, broad or attenuated, with concavities in their outer or inner edges, or both (see figs. 17, 18, 20). In the remarkable form shown in fig. 18, they are outward-curving with their outer edges concave. This distortion is even found in *virginiensis*, in

which the scale type is normally one of the most constant. In *P. macdunnoughii* the occurrence of malformation in the prongs is so frequent that deformities often exceed the perfectly developed examples. These abnormalities are of course more obvious when present in large numbers, but even when less numerous they catch the eye as differing from the symmetrical uniformity of pure scale types.

Such a mixture of types and distortion of form proves the *oleracea*-group insects to be of hybrid origin, and as such I deal with the individuals as species, though some may only be local races of others.

There may be some who will be reluctant to accept this very definite testimony of the scales. But the androconial scales are structures; of very fundamental nature, equal in importance to the genitalia, both being connected with the perpetuation of the species. The great antiquity of the androconial scales has been proved by paleontological evidence (Warren 1966). In such sheltered structures evolution can only become operative on effects engendered by use. Any recognizable deviation must therefore imply the fulfilment of some need. The characteristics of the androconial scales are known to accord with those of the genitalia. It is over fifty years since Chapman discovered this in connection with certain species of Lycaenidae (Chapman 1912). Twenty years later this was illustrated in species of the genus *Erebia* (Warren 1936). When discussing this accord with the late Dr. Jordan before the publication of my monograph of that genus, he emphasized the importance of the fact that there was no possibility of physical connection between the scales and genitalia, such as might exist in the case of special hairs appearing in certain places and the nature of the substance from which they grew. The only connection between the scales and genital structures lies in the correlation of each to a common specific nature. Such correlation between true, structural characters, proves the existence of what we call species: natural entities that have developed as a unit and remain distinctive. The knowledge that such correlation is a fact greatly enhances the value of characters derived from either source.

Once the effects of cross breeding on the androconial scales in the Palaearctic species were recognized for what they are, the presence of similar phenomena in Nearctic species could not fail to be noted. That some hybridisation existed among them was obvious, but at first there was difficulty in establishing which ancestral forms might have been involved. While still uncertain on this point Bowden sent me a series of Nearctic specimens he had bred, including hybrids between *P. oleracea* and *P. bryoniae*, and *P. napi* and *P. oleracea*.

The hybrids *napi* × *oleracea* gave a scale very similar to that of the Asiatic *P. dulcinea*. It was perfectly symmetrical with fully developed scent cell and body width, but with a markedly restricted neck (fig. 9). Most often in hybrids there is a reduction in size of the scent cell, sometimes a very marked one (see illustrations, Warren 1961, figs. 61-68). These hybrid scales suggested an advance of the normal *napi* scale (fig. 6), towards that of *P. dulcinea* which has a remarkably narrow neck in proportion to the great width of the body (fig. 5). I had conjectured that *oleracea* might be a hybrid *bryoniae* × *P. narina*, but by assuming the cross to have been *P. dulcinea* × *P. narina* several puzzling points were cleared away. Thus, there would be no reason why pure *bryoniae* races should not be found in the region of the hybrid. The "*bryoniae*"-like body contours existing in various Nearctic species could equally well have

derived from the *dulcinea* form. It would also account for the marking of the underside of the hind wings, which is so characteristic in Nearctic insects, for the sharply marked underside is normal in *dulcinea* and has led many writers into the mistake of placing *dulcinea* in the *melete* group. Shirôzu has emphasised that this cannot be so (Shirôzu, 1952), and I have illustrated that the scale bears no resemblance to that of the *melete* races (Warren, 1961).

The scale of the *oleracea* × *bryoniae* hybrid is very different from that of the *napi* × *oleracea* cross. It is symmetrical but distinctly transitional between the parental forms. The regular body contours resemble *bryoniae*, the short, thick neck is of the *oleracea* type, and the entire scale is shorter than is usual in the *bryoniae* races (fig. 11).

Structural transitions are a known feature in interspecific hybrids. I have illustrated a beautiful example of this in a natural hybrid *Erebia*, where four features of the genitalia showed perfect transitional formation, and this was so in each of the three specimens examined (Warren 1957).

Some years previously Bowden had crossed *P. virginienensis* with British *P. napi*. The scale in this hybrid shows the same phenomenon as in the *napi* × *oleracea* cross, the marked neck restriction in spite of the full development of the body (fig. 10). Considering the normal scale type in *virginienensis* (fig. 2), this hybrid form is exactly the reverse of what might have been expected.

Recently, Bowden made yet another cross with *P. virginienensis*. The European race used was said to be *P. bryoniae neobryoniae*. The scale in this hybrid (fig. 12), is in general shape and size a *bryoniae* type, close to either typical *bryoniae* or the subsp. *flavescens*. The *virginienensis* element is not recognizable, but there is considerable malformation, the remarkable hour-glass form of the basal prongs often being suggestive of that known in crosses between *napi* and *bryoniae*, though not quite as extreme. The length of the scale is remarkable when compared with that of the *virginienensis* scale, and the reduction of the body width also, when contrasted with that produced in the *virginienensis* × *napi* cross.

Altogether the *oleracea* and *virginienensis* crosses with *napi* and *bryoniae* emphasize the great difference in nature that must separate *napi* and *bryoniae*.

On consideration the data derived from these crosses are seen to have further remarkable significance. The fact that either of two species (oleracea and virginienensis), when crossed with a third (napi), produce in each case a uniform result in the shape of a scale of a given type (dulcinea), that is not normal to any of the three, is proof that all three must carry an element of the dulcinea strain. It also shows that the dulcinea strain is most potent in P. napi, for when P. virginienensis and P. oleracea are crossed with each other the dulcinea scale type does not appear.

We are fortunate in having proof of the last very important fact. Bowden has crossed these species. The scales of *virginienensis* and *oleracea* differ in many respects, but the scales of the hybrids are transitional, with most approach to *virginienensis*. There is much variation in size, small scales of both types occurring, malformation is frequent and extreme, These results show the two to be distinct species now, a fact reflected in the differences we have described between the *oleracea* and *virginienensis* crosses with *P. bryoniae*. Most noteworthy is the fact that the *dulcinea* type scale does not appear.

It is obvious that *P. napi* is more closely connected to *P. dulcinea* than to either of the Nearctic species which is not surprising. The Asiatic hybrid *P. kamtschadalis* develops a remarkable scale (fig. 23), that caused me to attach the species to the European race *adalwinda* in 1961. I then had only one specimen to rely on. Further material shows that *P. kamtschadalis* is a hybrid of the same nature as the Nearctic species. Fig. 24 shows one extreme scale type linking it with *P. narina*, many intermediate forms exist. The underside markings of *kamtschadalis* make an approach to the *dulcinea* markings, but they vary towards *adalwinda*.

As *kamtschadalis* spread across Asia the scale type became a little more advanced, attaining in Europe a slight increase in body width but with more perfection in neck formation (see fig. 22).

I have demonstrated that *napi* of central and southern Europe must have been evolved from *adalwinda*, and that when crossed with the latter now, the *napi* scale reverts to the original northern type (Warren 1961).

All these facts throw a new light on the old question of the relationship of *P. napi* and *P. bryoniae*. It must be accepted that *napi* is a western offshoot of the *dulcinea-narina-kamtschadalis-adalwinda* line. *P. bryoniae* when crossed with the Nearctic species *oleracea* or *virginiensis*, is found to be constitutionally distinct from that line: it cannot therefore be conspecific with *P. napi*. These two species have attained western Europe by different routes, and when crossed now are found to be still as remote from each other as *bryoniae* is from the Nearctic species.

When in course of time and distribution they came into contact the hybrid species (*dubiosa* and *pseudorapae*), have emerged, and spread over thousands of miles in central and south-western Asia and south-west Europe. These two hybrid species could be classed as one species, their constitution being fundamentally the same; but they were derived from different races of the ancestral forms, probably at different stages in their evolution, the slight difference in the size of their scales pointing to some constitutional difference.

A somewhat similar phenomenon has led to the spread of the *oleracea* group hybrids over two thirds of the Nearctic Region.

This is of course but a dim outline of past events, but that it explains the nature and relationship of *P. napi* and *P. bryoniae* at the present time, can scarcely be questioned.

It may be noted that in spite of their hybrid constitution the various species, or races, of the *oleracea*-group can usually be identified by the scale types, as illustrated, if some allowance is made for the hybrid abnormalities. The fig. 19 was misnamed on my 1963 plate (fig. 4, l.c.) as race *frigida* of *oleracea*, but the scale of the latter is very different. So far, in spite of past records, I have not seen any true *frigida* from northern inland regions. The subsp. *frigida* seems to be located almost entirely on the islands off the east coast of Quebec, Labrador and Newfoundland, though it is said to exist on the mainland of Quebec on the north shore of the St Lawrence. It is a little larger than the *oleracea* of inland localities. In some parts of Newfoundland *frigida* has two generations, and where it has the female of the second is considerably suffused with dark scaling on the upper side as the female of *P. bryoniae*. The female of the first generation is without any such suffusion. These Newfoundland females seem to be the only instance of this suffused type in any species of the *oleracea* group: it occurs, however, in the Asiatic *P. kamtschadalis* and the western *adalwinda*, doubtless inherited from the primeval *narina*.

I have been given much help with material for this paper. I am indebted to Mr. Colin W. Wyatt for the loan of specimens he captured in northern Canadian districts, and his patience in returning many for further examination, for it is always of great value to be able to check results again after having acquired further knowledge. I am also indebted to Dr. Cyril F. dos Passos, for his efforts to get me specimens from the eastern Islands, and to the Authorities of the British Museum (Natural History) for the loan of specimens of *P. kamtschadalis* and to Mr. T. G. Howarth for help in looking for them. To Mr. Yuri Nekrutenko of Kiev I owe thanks for further specimens from Kamchatka. My very sincere thanks are due to Mr. S. R. Bowden for his kindness and generosity in supplying me with series of specimens, the result of his many breeding experiments. It must of course be obvious that without his help this paper would not have been written.

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EXPLANATION OF PLATES

Androconial scales of Holarctic species of *Pieris*. ×450.

PLATE VI.

1. *P. narina*.
2. *P. virginiensis*. Ontario.
3. *P. oleracea*. 1st generation. New Hampshire.
4. *P. oleracea*. Single generation. N.W.T.
5. *P. dulcinea*. 1st generation. N. Korea.
6. *P. napi*. 1st generation. Lancashire.
7. *P. oleracea*. 1st generation. Ontario.
8. *P. narina*.
9. Hybrid. *P. napi* × *P. oleracea*.
10. Hybrid. *P. virginiensis* × *P. napi*.
11. Hybrid. *P. oleracea* × *P. bryoniae*.
12. Hybrid. *P. virginiensis* × *P. bryoniae neobryoniae*.

PLATE VII.

13. *P. macdunnoughii*. 1st generation. Colorado.
14. *P. venosa*. 1st generation. California.
15. *P. marginalis*. 1st generation. Oregon.
16. *P. oleracea*. 2nd generation.
17. *P. macdunnoughii*. 2nd generation. Utah.
18. *P. macdunnoughii*. 1st generation. Colorado.
19. *P. oleracea*. Single generation. N.W.T.
20. *P. marginalis*. 2nd generation. Washington.
21. *P. venosa*. 2nd generation. California.
22. *P. napi adalwinda*. Lapland.
23. *P. kamtschadalis*. Kamchatka.
24. *P. kamtschadalis*. Kamchatka.

New Forest Mercury Vapour Light Records for 1966

By L. W. SIGGS

1966 was not a good year as the following figures will show:—

	Nights	1966 Total	Average	Nights	1962-65 Total	Average
Mar.	29	2272	78	49	2211	45
Apl.	27	1965	73	105	15822	151
May	19	465	24	109	5293	49
June	29	3093	107	116	19252	166
July	31	6173	199	110	35345	321
Aug.	30	8919	297	119	28411	240
Sep.	28	2679	95	87	11772	135
Oct.	22	740	38	86	5591	65
Nov.	21	465	22	72	1919	27

It will be seen, however, that March and August were above average. The following additions to the Minstead list are recorded:—

Amathes agathina Dup.

Horisme tersata Schiff.

Cerapteryx graminis Linn.

Ortholitha mucronata Scop.

Nonagria sparganii Esp.

Eupithecia plumbeolata Haw.

Hyphenodes turfosalis Wocke.

E. tripunctaria H.-S.

The number of species recorded in 1966 was 317—well down on recent years. The total number of species recorded during the past 8½ years is 441.

308 species have turned up regularly each year since 1962. These may be divided as follows, according to the average numbers recorded over the years 1962-66:—

Over 100 ———	53	11-20 ———	47
51-100 ———	41	6-10 ———	45
21- 50 ———	55	1- 5 ———	67

Mr. J. H. Johnson of Chesterfield and I have compared notes as to the most common species. Here are my "top twenty", showing the average numbers recorded over the years 1962-66.

<i>A. exclamationis</i> L.	2962	<i>C. blanda</i> Schiff.	672
<i>N. pronuba</i> L.	2730	<i>A. monoglypha</i> Hufn. ..	601
<i>O. stabilis</i> Schiff.	1508	<i>O. incerta</i> Hufn.	522
<i>O. plecta</i> L.	870	<i>C. vaccinii</i> L.	398
<i>L. varia</i> Vill.	838	<i>D. rubi</i> View.	395
<i>O. cruda</i> Schiff.	802	<i>S. lubricipeda</i> L.	331
<i>A. secalis</i> L.	798	<i>C. alsines</i> Brahm.	292
<i>O. gothica</i> L.	786	<i>A. xanthographa</i> Schiff.	290
<i>P. gamma</i> L.	709	<i>E. janthina</i> Schiff.	289
<i>A. c-nigrum</i> L.	682	<i>L. pallens</i> L.	280

MIGRANTS put up a varied show. *Agrotis ipsilon* Rott. (1316), *Peridroma porphyrea* Schiff. (167), *Nycterosea obstipata* Fab. (11) and *Rhodometra sacraria* Linn. (7) gave the highest figures I have recorded here, and *Plusia gamma* Linn. (833) and *Laphygma exigua* Hübn. (18), the highest since 1962.

But *Lithosia quadra* Linn. (1) was well down from the usual 10-12, and no other migrant put in an appearance, not even *Leucania unipuncta* Haw., although several of that species have been taken in the Forest this year.